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of Japan, with a Description of a New Species  
(Hymenoptera, Formicidae)

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## Taxonomic Study of the Ant Genus *Pheidole* WESTWOOD of Japan, with a Description of a New Species (Hymenoptera, Formicidae)\*

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**Synopsis** Seven species of the genus *Pheidole* of Japan are treated. *P. ryukyensis* is described as new based on the worker, soldier and female. The male genitalia of six species, *nodus*, *fervida*, *pieli*, *indica*, *megacephala* and *fervens* are described and illustrated for the first time. Keys to Japanese species based on the worker, soldier and female are given.

### Introduction

The genus *Pheidole* was erected by WESTWOOD in 1840 based on the type-species *Atta providens* SYKES, 1835 from India. This genus is one of the largest genera of ants, including more than 400 species. It occurs from the tropics to the temperate zone of the world.

In 1874, Fr. SMITH described *P. fervida* and *P. nodus* from Hyogo (Hiogo), Honshu. This is the first record of the genus from Japan. WHEELER (1928) recorded *P.ieli* SANTSCHI, 1925 from Nagasaki, Kyushu, and OKAMOTO (1957) *P. indica* MAYR, 1878 from the southern coast of Shikoku. In Japan proper, these 4 species have been recognized. Another species *P. megacephala* (FABRICIUS, 1793) was reported from the Ryukyus (SONOBE, 1973). Thus, the genus *Pheidole* has been represented by 5 known species in Japan (ONOYAMA, 1980).

In the southern part of Japan including the Ryukyus, however, our knowledge of the species of *Pheidole* is in confusion. ABE *et al.* (1976) reported *P. fervens* Fr. SMITH, 1858 and *P. oceanica* MAYR, 1866 from Okinawa Island. Unfortunately, they did not note any morphological characters of these species. It is very probable that their identification of these species is doubtful. No further record of these two species has appeared since then. ONOYAMA (1976) recognized 7 species of *Pheidole* from the Ryukyus: *P. nodus*, *P. megacephala*, *P.ieli* and 4 undetermined species. In the present study, I have confirmed the occurrence of *P. fervens* Fr. SMITH and found a new species, *P. ryukyensis*, from the Ryukyus.

The male genitalia of this genus have hitherto been poorly studied. I examined the detailed structure of aedeagus of Japanese species, except for *P. ryukyensis* of which the male is unknown, and found that the ventrodistal margin of aedeagus

\* Contribution from the Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka (Ser. 3, No. 91).

is concave in various degrees. Among the genera of tribe Pheidolini, *Aphaenogaster* have a simple ventrodistal margin (CAGNIANT, 1966), and I found the similar condition in Japanese species of *Aphaenogaster* and *Messor*. The concave ventrodistal margin of aedeagus is probably one of the generic characters of *Pheidole*.

Before going further, I wish to express my sincere thanks to Prof. Y. HIRASHIMA and Assoc. Prof. K. MORIMOTO, Entomological Laboratory, Kyushu University, for their constant guidance. I am deeply indebted to Prof. W. L. BROWN, Jr., Cornell University, New York, for his kind comparison of the present materials with the collection of Museum of Comparative Zoology, Harvard University. My thanks are also due to Assoc. Prof. Y. MURAKAMI, Institute of Biological Control, Kyushu University, Dr. K. ONOYAMA, Obihiro University of Agriculture and Veterinary Medicine, Hokkaido and Mr. K. MASUKO, Sophia University, Tokyo, for their kindness in offering the valuable materials.

#### Measurements and Indices

Head length (HL): Maximum length of the head excluding mandibles, in full face view.

Head width (HW): Maximum width of the head excluding eyes, in full face view.

Cephalic index (CI):  $(HW \times 100)/HL$

Scape length (SL): Maximum length of the scape, excluding its articulation condyle.

WEBER's length of trunk (WL): Diagonally maximum length of trunk excluding pronotal cervix, in lateral view.

Total length of body (TL): Total outstretched length of the individual, from the mandibular apex to the gastral apex.

#### Genus *Pheidole* WESTWOOD

*Pheidole* WESTWOOD, 1840, Ann. Mag. nat. Hist., 6: 87.

*Oecophthora* HEER, 1852, Hausameise Madeiras: 15.

*Leptomyrma* MOTSCHULSKY, 1863, Bull. Soc. Nat. Moscou, 36: 17.

*Phidole* BINGHAM, 1903, Fauna Brit. India, Hym., 2: 220.

*Epipheidole* WHEELER, 1903, Bull. Amer. Mus. nat. Hist., 19: 664.

Type-species: *Atta providens* SYKES, 1835. Monotypic.

Worker caste dimorphic with the major worker (soldier) and the minor one (worker), usually not connected by intermediates.

Soldier: Head massive, occipital margin impressed in the middle forming two occipital lobes. Mandible large, stout, and strongly curved, with two apical teeth and one basal tooth. Palp formula with 2 maxillary and 2 labial. Antenna 12-segmented; club 3-segmented. Pronotum and mesonotum raised. Mesonotal-propodeal groove deeply impressed. Propodeum with a pair of spines dorsally.

Petiole emarginate above. Postpetiole broader than petiole, with rounded node. Gaster truncate.

Worker: Occipital margin of head shallowly emarginate or rounded. Mandible usually with two or three apical teeth followed by a row of uneven denticulae. Palp formula and antenna as in soldier. Trunk as in soldier but less raised pro- and mesonotum. Petiole and postpetiole more slender than in soldier.

Female: Head rectangular. Ocelli present. Occipital margin of head slightly concave or straight in the middle. Mandible like that of soldier. Trunk massive, broad, flat above; scutum overhanging pronotum; metanotum compressed; propodeal spines stout and short. Petiole, postpetiole and gaster like those of soldier, but more massive.

Male: Head much smaller than trunk. Eye large and prominent. Ocelli present. Mandible slender. Antenna 13-segmented, filiform; scape short; basal segment of flagellum globose. Trunk massive; scutum and scutellum slightly convex; pronotum and metanotum as in female; propodeal spines reduced, usually forming obtuse lobes. Fore wing with an open radial, two cubital and a discoidal cells. Subgenital plate pentagonal; basal margin with a distinct projection in the middle. In species examined, ventrodistal margin of aedeagus concave in lateral view.

### Key to Species of Japanese *Pheidole*

#### Soldier and Worker

1. Head of worker with flat or slightly concaved posterior border but without distinct occipital collar in full face view; surface of occiput of worker rugulose; apical segment of antenna more than twice as long as antennal segment X in soldier and worker.....2
- Head of worker with rounded posterior border and with low but distinct occipital collar in full face view; surface of occiput of worker smooth and shining; apical segment of antenna less than twice as long as antennal segment X in soldier and worker.....4
2. Small-sized species, HW 0.45 mm or less in worker, and HW 1.04 mm or less in soldier; in soldier, pronotum and mesonotum forming a single convexity in lateral view.....*pieli* SANTSCI
- Medium-sized species, HW 0.48 mm or more in worker, and HW 1.20 mm or more in soldier; in soldier, mesonotal region raised, so that pronotum and mesonotum forming a sinuate convexity in lateral view.....3
3. In soldier, antennal scrobes rather long, beyond the level of eyes in full face view; head of soldier, excluding mandibles, slightly longer than broad (CI 98 or more); in worker, HL 0.56 mm or more.....*fervida* Fr. SMITH
- In soldier, antennal scrobes shorter, not beyond the level of eyes in full face view; head of soldier, excluding mandibles, distinctly longer than broad (CI 94 or less); in worker, HL 0.53 mm or less.....*ryukyuensis* n. sp.

4. In soldier, occipital area of head smooth and shining, antennal scrobes short, not beyond the level of eyes; in worker, apical segment of antenna shorter, usually 0.25 mm or less in length. . . . . *megacephala* (FABRICIUS)
- In soldier, occipital area of head sculptured, antennal scrobes long, distinct, beyond the level of eyes; in worker, apical segment of antenna longer, usually 0.28 mm or more in length. . . . . 5
5. Postpetiole distinctly longer and higher than petiole. . . . . *nodus* Fr. SMITH
- Postpetiole neither longer nor higher than petiole. . . . . 6
6. In soldier, propodeal spines robust, directed upward and outward, eye larger, about 0.24 mm in greatest diameter; in worker, apical segment of antenna 0.26–0.30 mm and antennal segment X 0.15–0.18 mm in length. . . . .
- In soldier, propodeal spines slender and pointed, directed upward and curved backward, eye smaller, about 0.18 mm in greatest diameter; in worker, apical segment of antenna 0.31–0.32 mm and antennal segment X 0.19–0.20 mm in length. . . . . *indica* MAYR
- In soldier, propodeal spines slender and pointed, directed upward and curved backward, eye smaller, about 0.18 mm in greatest diameter; in worker, apical segment of antenna 0.31–0.32 mm and antennal segment X 0.19–0.20 mm in length. . . . . *fervens* Fr. SMITH

## Female

1. Apical segment of antenna more than twice as long as antennal segment X. . . . 2
- Apical segment of antenna less than twice as long as antennal segment X. . . . 4
2. Small-sized species with HW 1.00 mm or less; pronotum and scutum smooth and shining. . . . . *pieli* SANTSCI
- Medium-sized species with HW 1.20 mm or more; pronotum and scutum more or less sculptured. . . . . 3
3. Hairs abundant, especially on head and scutum; HW 1.40–1.60 mm; upper subdivision of mesepisternum smooth and shining. . . . . *fervida* Fr. SMITH
- Hairs sparse on head and scutum; HW about 1.20 mm; posterior half of upper subdivision of mesepisternum more or less sculptured. . . . . *ryukyuensis* n. sp.
4. Dorsal surface of scutum smooth and shining. . . . . *megacephala* (FABRICIUS)
- Dorsal surface of scutum more or less sculptured. . . . . 5
5. Petiole with distinct subpetiolar process; postpetiole longer and higher than petiole. . . . . *nodus* Fr. SMITH
- Petiole without distinct subpetiolar process; postpetiole neither longer nor higher than petiole. . . . . 6
6. Anterior margin of postpetiolar node straight as seen from above; antennal club shorter, apical segment of antenna less than 0.35 mm and antennal segment X less than 0.20 mm in length. . . . . *indica* MAYR
- Anterior margin of postpetiolar node rounded as seen from above; antennal club longer, apical segment of antenna more than 0.38 mm and antennal segment X more than 0.20 mm in length. . . . . *fervens* Fr. SMITH

*Pheidole ryukyuensis* n. sp.

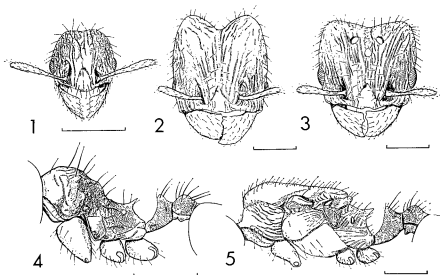
(Figs. 1-5)

**Soldier:** HW 1.22-1.26 mm, HL 1.30-1.35 mm, CI 92-94, SL 0.56-0.60 mm, WL 0.86-0.96 mm, TL 4.20-4.50 mm. (Five individuals were measured.)

Head, excluding mandibles, distinctly longer than broad; occipital lobes prominent and their posterior angles rather acute; median sulcus of head more or less distinct, reaching the middle of head, with feeble transverse impressions in full face view. Eye small, 0.14 mm in greatest diameter, with about 30 facets. Clypeus flat, with a low median notch at anterior border. Frontal area moderately concave, fused to clypeus. Antennal scape short, reaching just the middle of head; apical segment of antenna  $2.3-2.4\times$  as long as antennal segment X. Antennal scrobes short, diverging at the level of eyes in full face view. Gular dentition: with a midgular tubercle and paired mesal and lateral teeth.

Trunk less than half as broad as head. Pronotum raised but humeri rounded as seen from above. Mesonotum slightly convex. Propodeal spine stout, pointed, directed upward and backward. Petiole with crest blunt and horizontal as seen from behind. Postpetiole trapezoidal as seen from above, about  $1.7\times$  as broad as petiole. Legs short.

Head subopaque and costulate in full face view, but smooth and shining on sides. Mandible smooth and shining. Pronotum transversely rugulose; mesonotum and propodeum reticulate. Petiole and postpetiole finely reticulate. Gaster



Figs. 1-5. *Pheidole ryukyuensis* n. sp. — 1, Worker, head, full face view; 2, soldier, head, full face view; 3, female, head, full face view; 4, soldier, trunk, petiole and postpetiole, lateral view; 5, female, trunk, petiole and postpetiole, lateral view. Scale: 0.5 mm.

smooth and shining.

Hairs pale yellow, erect or suberect, sparse on head and body, more abundant on leg and antenna. Color reddish brown; edges of mandible and anterior border of clypeus darker.

*Worker:* HW 0.48–0.51 mm, HL 0.51–0.53 mm, CI 91–98, SL 0.48–0.51 mm, WL 0.60–0.64 mm, TL 2.15–2.21 mm. (Five individuals were measured.)

Head, excluding mandibles, longer than broad; occipital border slightly concave, without distinct occipital collar. Eye about 0.09 mm in greatest diameter. Antennal scape, when directed above, extending about 1/4 of its length beyond head. Antennal club like that of soldier in proportion. Trunk, petiole and postpetiole like those of soldier, but more slender.

Head rugulose and reticulate. Except head, sculptures as in soldier. Color yellowish brown; mandible and gaster darker.

*Female:* HW 1.26 mm, HL 1.10 mm, CI 115, SL 0.66 mm, WL 1.78 mm, TL 6.10 mm. (One individual was measured.)

Head, excluding mandibles, broader than long, with slightly concaved posterior margin in full face view; median sulcus distinct, extending from posterior border of head to median ocellus, with feeble transverse impressions. Antennal scape short, not beyond posterior ocelli. Eye large, 0.29 mm in greatest diameter.

Trunk robust; mesonotum slightly narrower than head; scutellum thin, overhanging metanotum in lateral view. Propodeal spine robust and blunt, directed upward and backward. Petiolar node compressed anteroposteriorly; dorsal crest of the node with horizontal margin and acute corners as seen from behind. Postpetiolar node rounded in lateral view, about 1.5× as broad as petiole, trapezoidal with rather acute anterior corners as seen from above. Gaster truncate.

Mandible smooth and shining. Head costate in full face view, smooth and shining on ventral surface and posterior half of lateral surface. Pronotum costulate; mesepisternum with posterior half of upper subdivision costulate, and the rest smooth and shining; scutum with dorsal median surface substrigulate, and the rest smooth and shining; propodeum porcate in lateral view. First gastric tergite longitudinally substrigulate on basal surface, and the rest of gaster smooth and shining.

Hairs as in soldier, but more abundant especially on petiole, postpetiole and gaster. Color dark reddish brown.

*Holotype:* Soldier (Type No. 2254, Kyushu Univ.), 29. iv. 1979, Mt. Omotodake, Ishigaki Is., Ryukyus, K. OGATA (Colony No. MY-0087).

*Paratypes:* 21 soldiers, 15 workers, 1 female, same data as holotype (from the same nest as holotype); 10 soldiers, 5 workers, 1. v. 1979, Yonehara, Ishigaki Is., K. OGATA (MY-0089); 2 soldiers, 2 workers, 26. iii. 1975, Mt. Omotodake, Ishigaki Is., K. ONOYAMA.

*Distribution.* Japan (Ryukyus).

*Remarks.* Colony No. MY-0087 was found under the stone and MY-0089 under the rotten wood on the floor of moist forests. This species most resembles

*P. fervida* and *P. pieli*, especially in the worker which can be distinguished from those of 2 species only by the length of head, but differs in having more elongate head of soldier (CI 92-94) and the sculptured scutum and mesepisternum of female.

*Pheidole fervida* Fr. SMITH

(Fig. 6)

*Pheidole fervida* Fr. SMITH, 1874, Trans. ent. Soc. Lond.: 407. — WHEELER, 1928, Boll. Lab. Zool. Gen. Agrar. Portici, 21: 107. — COLLINGWOOD, 1976, Ann. Hist. nat. Mus. Hung., 68: 302.

**Male genitalia:** Ventrodistal margin of aedeagus with a small concavity, subapical portion of the margin evenly rounded and apical portion of serrate edge moderately produced.

**Specimens examined:** 95 examples (12 colonies) from the following localities: [Hokkaido] Tomakomai; Maruyama, Sapporo City. [Honshu] Suzu City, Noto Pen., Ishikawa Pref.; Myôkô-Kôgen, Nagano Pref.; Shimogamo, Shizuoka Pref. [Shikoku] Omogo, Iyo, Ehime Pref. [Kyushu] Mt. Hikosan, Fukuoka Pref.; Mt. Taradake, Nagasaki Pref.; Mt. Tatera, Tsushima, Nagasaki Pref.; Sujiyu, Kujû, Ôita Pref.; Mt. Hakuchôsan, Kumamoto Pref.; Okawauchi, Hyûga, Miyazaki Pref.

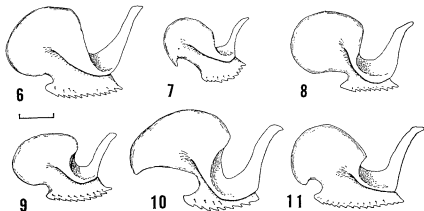
**Distribution.** Japan (Hokkaido, Honshu, Shikoku, Kyushu); Korea.

*Pheidole pieli* SANTSCI

(Fig. 7)

*Pheidole pieli* SANTSCI, 1925, Bull. Soc. Vaud. Sci. Nat., 56: 83. — WHEELER, 1928, Boll. Lab. Zool. Gen. Agrar. Portici, 21: 108. — COLLINGWOOD, 1976, Ann. Hist. nat. Hung., 68: 302.

**Male genitalia:** Ventrodistal margin of aedeagus with shallow but large concavity; subapical portion of concavity produced ventroproximally forming acute



Figs. 6-11. Aedeagus, lateral view. — 6, *Pheidole fervida*; 7, *P. pieli*; 8, *P. indica*; 9, *P. nodus*; 10, *P. fervens*; 11, *P. megacephala*. Scale: 0.1 mm.



angle and apical portion of serrate edge not produced.

*Specimens examined:* 156 examples (9 colonies) from the following localities: [Honshu] Kasayama, Hagi City, Yamaguchi Pref. [Shikoku] Shimizu, Kochi Pref.; Okinoshima, Kochi Pref. [Kyushu] Nomozaki, Nagasaki Pref.; Okinoshima Is., Fukuoka Pref.; Ushitoko, Yakushima Is. [Ryukyus] Santarô-Tôge, Amami-Oshima Is.; Mt. Omotodake, Ishigaki Is.

*Distribution.* Japan (southern part of Honshu, Shikoku, Kyushu, Ryukyus); China, Korea.

*Pheidole nodus* Fr. SMITH

(Fig. 9)

*Pheidole nodus* Fr. SMITH, 1874, Trans. ent. Soc. Lond.: 407. — WHEELER, 1906, Bull. Amer. Mus. nat. Hist., 22: 307. — YASUMATSU, 1962, Mushi, 36: 96.

*Pheidole rhombinoda* MAYR, 1878, Verh. zool.-bot. Ges. Wien, 28: 678.

*Pheidole rhombinoda* var. *micantiventris* MAYR, 1897, Term. Füzet., 20: 247.

*Pheidole nodus* subsp. *rhombinoda*: WHEELER, 1929, Amer. Mus. Nov., 361: 3.

*Pheidole nodus* var. *praevertexata* WHEELER, 1929, *Ibid.*, 361: 3.

*Male genitalia:* Aedeagus similar to that of *P. fervida* and *P. indica*, but apical portion of serrate edge less produced.

*Specimens examined:* 89 examples (14 colonies) from the following localities: [Honshu] Yamaguchi City, Yamaguchi Pref. [Shikoku] Cape Ashizuri, Kochi Pref. [Kyushu] Fukuoka City, Fukuoka Pref.; Okinoshima Is., Fukuoka Pref.; Mt. Ariake, Tsushima, Nagasaki Pref.; Cape Sata, Kagoshima Pref.; Mt. Aikodake, Yakushima Is.

*Distribution.* Japan (southern part of Honshu, Shikoku, Kyushu, Ryukyus); India, Sri Lanka, China, Taiwan, Korea.

*Pheidole indica* MAYR

(Fig. 8)

*Pheidole indica* MAYR, 1878, Verh. zool.-bot. Ges. Wien, 28: 679. — FOREL, 1902, Rev. Suisse Zool., 10: 198. — OKAMOTO, 1957, Gensei, 5: 39.

*Male genitalia:* Aedeagus similar to that of *P. fervida* and *P. nodus*, but ventrodistal concavity deeper and forming acuter apical process of serrate edge.

*Specimens examined:* 93 examples (6 colonies) from the following localities: [Shikoku] Katsurahama, Kochi Pref.; Usa, Kochi Pref. [Kyushu] Cape Sata, Kagoshima Pref.; Ibusuki, Kagoshima Pref. [Ryukyus] Chinen, Okinawa Is.; Shuri, Okinawa Is.

*Distribution.* Japan (southern part of Honshu, Shikoku, Kyushu, Ryukyus); India, Burma, Sri Lanka.

*Pheidole fervens* Fr. SMITH

(Fig. 10)

*Pheidole fervens* Fr. SMITH, 1858, Cat. Hym. Brit. Mus., 6: 176. — WILSON & TAYLOR, 1967, Pac. Ins. Mon., 14: 45. — ABE *et al.*, 1976, Ecol. Stud. Nat. Cons. Ryukyu Isl., 2: 115.

*Pheidole javana* MAYR, 1867, Tijdschr. Ent., 10: 98. — WHEELER, 1930, Peking nat. Hist. Bull., 5: 63.

**Male genitalia:** Ventrodistal margin of aedeagus with a large concavity, sub-apical portion of the margin with rather acute corner and apical portion of serrate edge strongly produced.

**Specimens examined:** 173 examples (14 colonies) from the following localities: [Kyushu] Shiroyama, Kagoshima City, Kagoshima Pref.; Cape Sata, Kagoshima Pref.; Teuchi, Koshiki-Jima Is., Kagoshima Pref.; Onoaida, Yakushima Is. [Ryukyu] Mt. Omotodake, Ishigaki Is.; Yonehara, Ishigaki Is.; Sonai, Iriomote Is.

**Distribution.** Japan (southern part of Kyushu, Ryukyu); Sri Lanka, Burma, Singapore, China, Java, Borneo, Taiwan, Oceania.

*Pheidole megacephala* (FABRICIUS)

(Fig. 11)

*Formica megacephala* FABRICIUS, 1793, Ent. Syst., 2: 361.

*Pheidole megacephala*: ROGER, 1863, Verz. d. Formicid. 30. — WHEELER, 1930, Peking nat. Hist. Bull., 5: 63. — SONOBE, 1973, Sesoko Mar. Sci. Lab. Tech. Rep., (2): 15.

**Male genitalia:** Ventrodistal margin of aedeagus with a round concavity, sub-apical portion of the margin with rather acute corner and apical portion of serrate edge moderately produced.

**Specimens examined:** 52 examples (10 colonies) from the following localities: [Ryukyu] Shuri, Okinawa Is.; Chinen, Okinawa Is.; Yonehara, Ishigaki Is.; Kabira, Ishigaki Is.; Sonai, Iriomote Is.; Funaura, Iriomote Is.; Ōtomi, Iriomote Is.; Minami-Daito Is.

**Distribution.** Japan (Ryukyu); Tropicopolitan.

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